Environment & Ecology 29 (3B) : 1606—1610, 2011
 ISSN 0970-0420

Evaluation of Soil Fertility Status and Quality of Irrigation Water of Lateritic Soils in Medak District of Andhra Pradesh

T. BASANTA*, KH. CHANDRAKUMAR AND G. JAYASHREE[1]

Department of Agricultural Chemistry & Soil Science, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur 741252, India
[1]Department of Soil Science & Agricultural Chemistry Rajendranagar, ANGRAU, Hyderabad 500030, India
E-mail : basantagribios43@gmail.com
**Correspondence*

Abstract

Soils of Medak district of Andhra Pradesh are red to dark brown in color, sandy clay loam to clay in texture, moderately acidic to neutral in soil reaction and with shallow to moderate depths. The soils of the area are developed from gently sloping physiography of upper plateau or from gently sloping summit of lower plateaus and some are developed in moderately sloppy terrain with undulations. They are fairly well drained with slight to moderate erosion. The soils of the study area except Krishnapur series (Inceptisol), are mostly Alfisols due to presence of illuvial layer with higher base saturation. Due to presence of more amorphous materials and geolites inferred higher CEC compared to other red soils. The soils have high percentage of sesquioxides which facilitates aggregation. The dominance of exchangeable bases on the exchange complex was in the order of Ca^{2+},>Mg^{2+}>Na^{+}>K^{+}. All the samples were non saline. Most of the surface samples recorded medium organic carbon content. The available N content recorded low due to rapid mineralization leading to formation of NO_3^--N to leaching losses. The available P ranged from low to medium. The available K was low in all the locations except few. The investigated area has low fertility status. The study area has sufficient quantities of DTPA extractable micronutrients viz. Zn, Cu, Fe and Mn. The water samples were neutral to alkaline in reaction. The dominance of cations and anions in these samples were in the order of Ca^{2+}>Mg^{2+}>Na^{+}>K^{+} and Cl^->HCO_3^->CO_3^{2-} respectively. These samples were categorized under C_3S_1 which infers safe for irrigating crops.
Key words : Fertility evaluation, Lateritic landform, Water quality.

Andhra Pradesh state has variable types of soil. The laterite and lateritic soils occur in patches, the southwestern and southern part of the district and cover about 84,652 ha (8.7%). They occur as caps (50—60 m thick) over Deccan Traps in Zaheerabad and Narayankhed areas (1). They are found in the east coast in the districts of Srikakulam, Visakhapatnam, East Godavari, Nellore, and in Medak in Telangana region of the state. Laterite soils are typically formed under tropical climate experiencing alternate wet and dry seasons. These soils thus formed are rich in sesquioxides devoid of bases and primary silicate minerals, hard or capable of hardening like bricks when exposed to drying after wetting. Red and laterite soils are generally acidic and have low CEC, low to moderate base saturation. Due to intensive leaching these soils show deficiency of nutrients such as phosphorus, potassium, nitrogen and are also associated with the toxicity of Fe and Al. Surface crusting, nutrient imbalances, iron and aluminium toxicity, soil erosion, and inundation in coastal region are the major constraints in these soils (2). High grazing and human interference further accentuates severity of erosion which ultimately reduces biological productivity. Evaluation of soils fertility status and the water quality for irrigation is the first milestone to be developed for sustainable and eco-friendly land use and management practices. The investigation was conducted to evaluate the soil fertility and water quality status of the district for agricultural land.

Methods

Six soil profiles viz. Rejental, Parvatapur, Algol, Bilalpur, Zaheerabad, and Krishnapur, representing the study area were selected based on the topogra-

Table 1. Physical and chemical characteristics of soils. *[cmol (p+) kg^{-1}], WHC-water holding capacity, BS-Base Saturation.

Depth (cm)	Sand (%)	Silt (%)	Clay (%)	WHC (%)	$CaCO_3$ (%)	OC (%)	pH (1:2)	EC (dS/m)	CEC*	BS (%)
Rejental Series : Alfisols										
0—15	33	14	53	24.4	nil	0.570	6.0	0.067	18.3	55.9
15—25	32	8	60	28.8	nil	0.495	6.2	0.077	22.4	59.2
25—45	23	8	69	30.7	nil	0.270	6.6	0.063	25.5	46.3
45—90	31	24	45	32.6	nil	0.210	6.8	0.079	16.3	36.5
Parvatapur Series : Alfisols										
0—15	28	22	50	24.6	nil	0.450	6.2	0.060	23.1	64.4
15—33	24	16	60	27.3	nil	0.301	6.4	0.065	25.2	54.4
33—44	26	12	62	29.0	nil	0.270	6.3	0.102	24.3	53.2
Algol Series : Alfisols										
0—15	48	15	37	21.8	nil	0.495	5.9	0.061	15.0	76.2
15—45	27	8	65	26.2	nil	0.270	6.3	0.118	14.7	43.8
45—75	17	7	76	28.0	nil	0.150	7.0	0.094	17.0	31.7
Bilalpur Series : Alfisols										
0—18	37	15	48	23.0	nil	0.330	6.2	0.275	17.1	87.5
18—50	21	12	67	26.8	nil	0.360	5.9	0.153	26.8	54.0
50—95	17	18	65	28.0	nil	0.225	6.4	0.112	24.8	49.0
Zaheerabad Series : Alfisols										
0—16	51	12	37	26.0	nil	0.405	6.4	0.030	27.2	47.0
16—70	46	7	47	29.0	nil	0.300	6.1	0.103	28.7	50.2
70—95	52	8	40	32.9	nil	0.045	7.0	0.098	29.8	34.8
Krishnapur Series : Inceptisols										
0—14	61	8	31	49.8	nil	0.330	5.4	0.134	12.0	78.6
14—50	73	6	21	48.4	nil	0.210	5.9	0.036	15.3	68.8
50—65	47	11	42	32.0	nil	0.150	6.1	0.012	20.1	53.7

phy and physiographic units. The respective water samples from irrigation sources (open bore wells) were also collected for analytical study.

Geographical Setting

Medak district of Andhra Pradesh is located at 17°27′ and 18°18′ N latitudes and 79°10′ and 77°28′ E longitudes. Physiographically, the district is located at an altitude of 306 to 662 m above MSL covering an area of 971,086 ha (3.5% of the state). The district forms a part of Southern Deccan Plateau. Laterite soils cover an area of 82,869 ha (8.7%) in the Medak district occupying 61,793 ha (56.6%) in Zaheerabad area alone followed by Sadasivapet (29.4%). Sheet-wash and retreat of hill slopes are the major geomorphic processes responsible for sculpturing of the present day landforms under semi-arid conditions. The plateau has two erosional surfaces with altitudes of 150–600 m and 300–900 m above MSL. The average rainfall is 890 mm of which 76, 14 and 8% during southwest monsoon, northeast monsoon and summer season. The mean monthly temperature ranges from 13.0 to 38.8 C. The mean relative humidity during forenoon and afternoon are 80 and 42% respectively. The common rock is basalt which is composed of pigeonite-augite, andesite-labradorite, brown or green glass altering to plagonite and rarely olivine and microcrystalline silica and magnetite. Of the total cropped area (42%), about 47% is under cereals; 28% under pulses; 18% is under commercial crops; 2% is under oilseed crops and 5% is under horticultural crops.

Field and Laboratory Studies

The analysis of physical and chemical character-

Table 2. Soil fertility status of lateritic soils of Medak district.

Profile location	Depth (cm)	Available nutrient content (kg/ha) N	P_2O_5	K_2O	Ca	Exchangeable cations c mol (p^+)/kg Mg	Na	K	Available micronutrient content (ppm) Zn	Fe	Cu	Mn
1. Rejental	0—15	150.52	20.38	82.88	5.8	3.8	0.45	0.18	0.975	26.92	6.256	80.00
	15—25	112.89	15.90	94.08	7.2	5.2	0.69	0.16	1.020	22.59	4.048	76.90
	25—45	100.35	9.40	84.32	6.8	4.2	0.65	0.15	1.182	24.54	4.244	50.60
	45—90	37.63	2.24	84.50	3.0	2.4	0.44	0.12	0.646	20.26	2.168	45.30
2 Parvatapur	0—15	188.16	16.80	85.12	8.1	5.9	0.56	0.32	0.768	41.78	2.372	77.34
	15—33	163.07	22.84	82.88	8.8	3.9	0.80	0.21	0.803	35.80	3.972	73.42
	33—44	125.44	44.57	80.64	7.4	4.6	0.72	0.21	0.845	13.77	2.182	37.37
3. Algol	0—15	150.52	24.64	86.00	6.4	4.3	0.45	0.30	1.020	11.29	2.540	64.32
	15—45	100.35	68.76	91.84	8.6	5.6	0.77	0.25	1.240	7.69	1.926	49.74
	45—75	25.08	21.50	81.76	7.8	3.2	0.87	0.20	0.622	22.66	1.416	57.98
4. Bilalpur	0—18	225.79	48.83	182.56	8.4	5.3	0.97	0.22	2.120	19.60	5.940	73.72
	18—50	163.07	16.35	131.04	8.8	4.7	0.78	0.21	1.059	19.56	3.346	74.00
	50—95	100.34	31.36	104.16	6.5	4.3	1.17	0.30	0.698	23.24	2.760	59.18
5. Zaheerabad	0—16	210.52	56.89	134.40	8.0	3.5	0.96	0.34	1.765	26.22	5.800	73.34
	16—70	108.42	15.60	82.88	8.4	4.9	0.89	0.24	0.515	15.58	2.184	48.64
	70—95	70.01	10.08	107.52	5.7	4.3	0.17	0.16	0.121	20.26	1.964	64.88
6. Krishnapur	0—14	170.54	20.83	90.72	6.0	2.5	0.72	0.22	0.780	34.94	3.644	78.86
	14—50	150.13	21.73	84.50	6.4	3.0	0.94	0.20	0.392	4.77	5.014	10.28
	50—65	50.76	24.03	82.00	5.8	4.3	0.58	0.13	0.367	4.80	0.459	8.280

istics of soils was carried out following standard analytical procedures. Undisturbed core soil samples were collected determining hydraulic conductivity and bulk density. Infiltration studies were carried out *in situ* using double ring infiltrometer. Particle size distribution was determined by hydrometer method (3), soil reaction by pH meter (4) and EC by conductivity bridge. The CEC was determined by saturation of soils with IN sodium acetate (pH 8.2). Organic carbon was determined by Walkley and Black method (5), available nitrogen by alkaline permanganate method (6), available phosphorus by Olsen's method (7), and available potassium by flame photometer. The available micronutrients viz., Zn, Fe, Mn and Cu were determined by atomic absorption spectrophotometer in DTPA extract (8). The concentrations of CO_3^{2-}, HCO_3^-, Ca^{2+}, Mg^{2+}, Na^-, Cl^- in irrigation water were determined by the procedure given by Tandon (9) and K^+ by flame photometer.

Results and Discussion

Soil Physical Characteristics

The present study revealed that the soil depth varied from shallow to moderately shallow (45—95 cm). Soil depth was moderately deep with respect to Rejental, Bilalpur and Zaheerabad. The soils of the study area except Krishnapur series (Inceptisol), are Alfisols due to presence of illuvial layer with higher base saturation. Gravel content ranged from 14.16 to 70%. Profiles of Rajental, Parvatapur, Bilalpur and Zaheerabad revealed clayey texture throughout the profile while Algol profile was clayey in the bottom layers only and Krishnapur soil was sandy clay loam (Table 1). The maximum accumulation of clay was found in lower layers compared to surfaced layer in all the profiles coupled with increasing bulk density. Zaheerabad and Parvatapur series are underlined by a hard layer of iron stone (plinthite) which limits deeper root growth. As surface soils had more organic matter content, influenced aggregate formation with lower bulk density. Much variation from 1.2 cm/ha to 20.6 cm/ha was observed in different profiles with respect to hydraulic conductivity. In general the hydraulic conductivity decreased with increase in depth of the profile due to increase in clay content. The investigated area has low water holding capacity (WHC). They recorded a difference of 10.3—31.1% at 1/3 bar and 3.3 to 14.7% at 15 bar with more in deeper layers due to higher percentage of clay and silt in the deeper layers.

The highest infiltration rate and cumulative infil-

Table 3. Physico-chemical properties of the irrigation water.

	Place of collection	pH	EC dS/m	CO_3^{2-} meq/l	HCO_3^- meq/l	Ca^{2+} meq/l	Mg^{2+} meq/l	Cl^- meq/l	Na meq/l	K meq/l	RSC (%)	SAR
1	Bore well 1	6.91	1.40	0.65	7.8	7.1	2.5	5.4	4.0	0.17	Nil	1.29
2	Bore well 2	6.92	1.40	0.65	6.6	8.2	1.4	6.0	3.6	0.93	Nil	1.16
3	Bore well 3	7.06	1.20	0.48	7.8	7.4	1.4	3.6	3.8	0.11	Nil	1.28
4	Bore well 4	6.84	1.10	0.48	6.0	7.1	1.8	4.2	2.5	0.12	Nil	0.83
5	Bore well 5	7.30	0.96	0.32	5.0	7.1	1.0	4.0	2.5	0.36	Nil	0.87
6	Bore well 6	8.01	1.23	0.48	5.8	7.4	1.6	4.0	3.0	0.32	Nil	1.00
7	Bore well 7	7.01	1.14	0.65	6.2	7.1	2.0	4.0	1.5	0.19	Nil	0.49
8	Bore well 8	7.20	1.22	0.48	6.2	6.0	1.6	4.0	2.5	0.13	Nil	0.90
9	Bore well 9	7.88	1.62	0.65	6.6	7.4	1.2	6.0	5.2	0.03	Nil	1.77
10	Bore well 10	8.00	1.40	0.65	7.8	6.4	2.5	4.0	4.0	0.11	Nil	1.29
11	Bore well 11	7.12	1.36	0.48	6.6	7.0	3.0	5.4	3.6	0.14	Nil	1.14
12	Bore well 12	7.31	1.40	0.65	6.6	7.1	3.0	5.1	3.5	0.12	Nil	1.10

tration was observed in Krishnapur profile due to lower clay content.

Soil Fertility Status

The soil reaction ranged from moderately acidic to neutral in the different profiles (Table 2). In general the soil reaction was more at the bottom layers compared to surface layers in all the profiles studied due to accumulation of exchangeable cations by illuviation which is common in laterites. All the samples were non saline. The increase in CEC with depth was attributed to increase in clay content at lower depths. Low values of CEC in Krishnapur were because of low clay content. The higher CEC in these soils compared to other red soils is due to the presence of more amorphous materials and geolites. The dominance of exchangeable cations was in the order of Ca<Mg<Na<K and higher values observed at subsoil due to removal of bases from surface layers by laterization. Organic carbon (OC) content decreased with increase in depth. In general the OC% was low because of the tropical nature which facilitates rapid mineralization. Due to continuous addition of organic manures and better management practices, surface samples recorded medium organic carbon content. The available N content recorded low due to rapid mineralization leading to formation of NO_3^--N to leaching losses and decreased with depth in all the profiles. The available phosphorus in the pedons ranged from low to medium. The surface samples recorded higher P content due to the confinement of crop cultivation to the rhizosphere and supplementing of depleted phosphorus through external fertilizer sources and fixation of more phosphorus in sub-surface layers. The available potassium was low in all the locations except few and decreasing with depth due to intense weathering, release of labile potassium from organic residues, application of potassium fertilizers and upward translocation of potassium from lower depth along with capillary rise of ground water. The favorable soil reaction coupled with the parent material bearing these minerals might have contributed to sufficient quantities of DTPA extractable micronutrients viz. Zn, Cu, Fe and Mn. The decrease in micronutrient content with depth was due to increase in pH and decrease in organic carbon content.

Quality of Irrigation Water

Irrigation water, irrespective of source, always contains some soluble salts. The irrigation water samples collected were neutral to alkaline in reaction whose pH ranged from 6.91 to 8.01 (Table 3). Out of twelve samples nine (75%) samples were neutral in reaction and three samples (25%) were alkaline in reaction. The EC of the irrigation water samples ranged from 0.96 to 1.62 dS/m. All the samples were non saline. The aboundance of dissolved cations follows as $Ca^{2+}>Mg^{2+}>Na^{+}>K^{+}$ and for the anions the trend follows as $Cl^->HCO_3^->CO_3^{2-}$. The residual sodium carbonate (RSC) percentages were nil in all the samples and the sodium adsorption ratio (SAR) in all the samples were below 10. All samples used for irrigat-

ing crops are under C_3S_1 category i.e. safe for use and can continue for irrigating most of the crops.

Conclusion

Soils of the investigated area have been kept under Alfisols and Inceptisols orders. In most of the pedons the percentages of coarse fragments are moderate which limits crop production. Shallow to moderately deep soils predominates, for them cultivation of shallow rooted crops like zinger, turmeric, rice etc are recommended. As the pH of some soils (Krishnapur) is slightly acidic, so liming may be recommended for the cultivation of susceptible crops like legume crops. The investigated areas have low fertility status as evidenced from the result. The phosphorus status in surface soils was mainly medium (56%) closely followed by low (42%), 88% of surface samples recorded low potassium. Application of FYM/organic matter will increase physical chemical and biological fertility. Judicious use of NPK fertilizers specifically integrated nutrient management (INM) practices will yield a positive result. Improved irrigation technologies like drip system to the susceptible crops is advised to minimize the burning hazard as the water have moderately high salt content.

References

1. Reddy R. S., S. L. Naidu, L. G. K. Ramesh Kumar, S. C. Budhilal and P. Krishnan. 2005. *Land Resources of Medak district, Andhra Pradesh,* NBSS Publ. No. 791, NBSS & LUP, Nagpur, India.
2. Sehgal J. L., O. Challa, C. J. Thampi, A. K. Maji and S. R. N. Bhushana. 1998. *Red and lateritic soils of India. Red and lateritic soils. Volume-2. Red and lateritic soils of the world* 1—18.
3. Gee G. H. and J. W. Bauder. 1986. Particle size analysis. Pp. 383—411. *In* A. Klute (ed). *Methods of soil analysis Part-1.* Am. Soc. Agron., Inc., Wisconsin, USA.
4. Jackson M. L. 1967. *Soil chemical analysis.* Prentice Hall of India Pvt. Ltd., New Delhi, India.
5. Walkeley A. and I. A. Black. 1934. An examination of the Degjareff method for determining soil organic matter and a proposed modification of the chromic acid titration method. *Soil Sci.* 37 : 29—33.
6. Subbaiah B. V. and G. L. Asija. 1956. A rapid procedure for the estimation of available nitrogen in soils. *Curr. Sci.* 25 : 259.
7. Olsen S. R., C. V. Cole, F. S. Watanable and L. A. Dean. 1954. *Estimation of available phosphorus in soil by extraction with sodium bicarbonate.* Circular, USDA, 939.
8. Lindsay W. L. and W. V. A. Norwell. 1978. Development of DTPA test for Zn, Fe, Mn and Cu. *Soil Sci. Soc. Am. J.* 52 : 297—309.
9. Tandon H. L. S. 2005. *Methods of analysis of soil, plants, waters, fertilizers and organic matter.* Fertil. Devel. and Consul. Organ., New Delhi, India.